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*Original Research*

# Investigation of antibacterial activity of silver nanoparticles against staphylococcus aureus strain

Silver nanoparticles

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**Abstract**
Aim: Staphylococcus aureus (S. aureus) is an important pathogen that causes hospital and community infections. Silver nanoparticles (AgNPs) have antimicrobial activity against both gram-positive and gram-negative bacteria. Colloidal silver (Ag) based antiseptics have become more popular once again because of the increase in antibiotic resistance. Silver nanoparticles mostly show their effectiveness against bacteria by disrupting bacterial DNA replication and bacterial cytoplasm membranes. In this study, it was aimed to investigate the antibacterial effect of silver nanoparticles against S. aureus strain.
Material and Methods: The antibacterial effect of AgNPs was investigated against S. aureus ATCC 6538 reference strain. The Broth dilution method was used in the analysis of Minimum Inhibitory Concentration (MIC) values of silver nanoparticles. Brain Heart Infusion (BHI) agar plates were used in the Minimum Bactericidal Concentration (MBC) test.
Results: The investigation showed that silver nanoparticles, at a concentration of 1 mg/ml, were effective against S. aureus.
Discussion: As a result, the antibacterial activity of silver nanoparticles has been determined and further research is required.

**Keywords**
Staphylococcus Aureus, Silver Nanoparticles, Antibacterial

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## Introduction

Staphylococcus aureus (S. aureus) is both a human pathogen and a commensal bacterium [1]. It causes many infections such as skin and soft tissue infections, pneumonia, bacteremia, infective endocarditis, septic arthritis, and osteomyelitis [2].

The widespread use of antibiotic or antimicrobial agents has led to global concerns such as the rapid emergence of antimicrobial-resistant strains, long-term treatment of infection and increased risk of mortality [3,4]. Because of bacterial evolution and widespread antibiotic use, drug resistance of S. aureus has significantly increased in recent years [5]. Effective agents against antibiotic-resistant S. aureus infections are needed.

Silver nanoparticles (AgNPs) smaller than 100 nm in at least one dimension have drawn a lot of interest due to their antimicrobial effect [6]. Ag-based antiseptics have become more popular once again because of the increase in antibiotic resistance [7]. Colloidal silver (Ag) has been reported to be effective against gram-positive and gram-negative bacteria [8]. Their strategy for attacking staphylococci involves causing permanent harm to bacterial cells by preventing bacterial DNA replication, degrading bacterial cytoplasm membranes, or affecting intracellular adenosine-5'-triphosphate (ATP) levels [9].

In this study, we aimed to examine the antibacterial effect of Ag-NPs on the S. aureus ATCC 6538 strains.

## Material and Methods

The study was carried out at Çukurova University, Medical Microbiology Department between 25.03.2022 and 10.08.2022. AgNPs synthesis was performed according to a previously described method [6]. The S. aureus ATCC 6538 reference strain was used to investigate the antibacterial efficacy of silver nanoparticles. This study was conducted in accordance with ethical rules.

*Minimum Inhibitory Concentration (MIC) Determination*

A standard broth microdilution in MHB was used for the 96-well microtiter plates used for the AgNPs susceptibility testing in accordance with recommendations from the Clinical and Laboratory Standards Institute (CLSI). The test strain was exposed to 0.25-4 mg/mL AgNPs to determine the MICs of AgNPs. Phosphate-buffered saline was used to prepare AgNPs solutions [10].

*Minimum Bactericidal Concentration (MBC) Determination*

Aliquots of 50 µl from each tube that exhibited no bacterial growth were inoculated on BHI agar plates after the MIC of the AgNPs was determined. The plates were incubated for 24 hours at 37°C [11].

## Results

According to the study, the value of AgNPs is efficient against S. aureus strain at 1,2, and 4 mg/mL concentration. BHI agar plate was inoculated with the suspension from the tubes containing 1, 2, and 4 mg/ml. At any of the concentrations (1, 2, or 4 mg/ml), no bacterial growth occurred. As a result, the MIC and MBC values of AgNPs were found to be effective at 1 mg/ml dilution against S. aureus strain.

## Discussion

S. aureus is a clinically significant bacterium and a serious public health concern [12]. S. aureus infections, particularly those brought on by antibiotic-resistant strains, are becoming a worldwide epidemic [13].

Ag-NPs have been reported to represent a new generation of antimicrobials [14]. AgNPs are non-toxic and exhibit broad-spectrum antibacterial effects [15]. The antibacterial activity of silver particles against the S. aureus strain was investigated in the study. At a concentration of 1 mg/ml, silver particles in the study were found to be effective against S. aureus.

AgNPs have been determined to completely inhibit bacterial growth at a concentration of 4µg/ml [6]. Additionally, it has been observed that Ag+ ions and Ag-based compounds are effective against resistant bacteria like Methicillin-resistant S. aureus [16]. It has been reported that AgNPs are efficient against S. aureus and that other investigations have shown similar results. The silver particles' low MIC values demonstrated their effective anti-staphylococcal activity and offered a hope for the future with more clinical applications [17].

Ag nanoparticles show great potential as antimicrobial agents. It has been reported that Ag nanoparticles can lead to valuable discoveries in various fields such as medical technology and antimicrobial systems [18].

Consequently, AgNPs were found to be effective against S. aureus and more comprehensive studies should be done.

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***Scientific Responsibility Statement***

*The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.*

***Animal and human rights statement***

*All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.*

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***Conflict of interest***

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